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Adolf et al.

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(54) **MEDICAL DEVICE LOADING SYSTEMS, DEVICES, AND METHODS**

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A61M 1/36 (2006.01)
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(52) **U.S. Cl.**
CPC ***A61M 60/847*** (2021.01); ***A61M 1/3622*** (2022.05); ***A61M 1/367*** (2013.01);
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(58) **Field of Classification Search**
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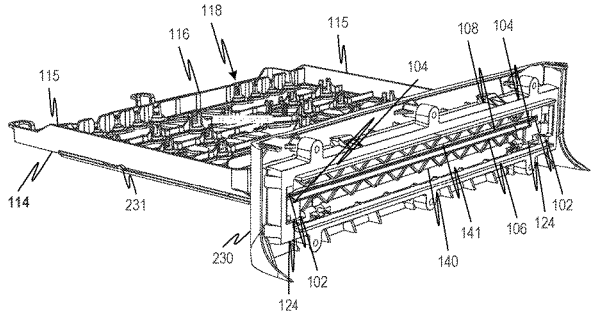
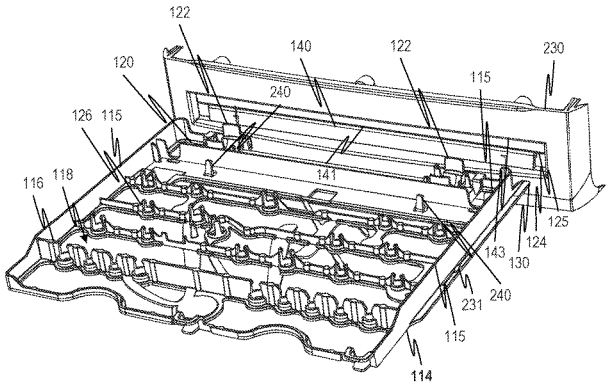
(57) **ABSTRACT**

A cartridge insertion system includes a chassis supporting a fluid circuit, the chassis having a forward end with key pins projecting from the forward end and a rear end. The system also includes a medical treatment device with a slot opening closed by doors having a major dimension and having key openings spaced apart a same distance as the key pins on the chassis, such that when the chassis is pushed toward the slot opening, the key pins enter the key openings before the forward end meets the doors. The key pins push against latches that hold the door locked shut, so that the doors will not open if a cartridge without key pins is pressed against the door. When a cartridge with key pins is used, the doors unlock and allow the cartridge to be inserted.

16 Claims, 7 Drawing Sheets





(51) **Int. Cl.**
A61M 60/113 (2021.01)
B01L 9/00 (2006.01)

(52) **U.S. Cl.**
CPC ***A61M 60/113*** (2021.01); ***B01L 9/527*** (2013.01); *A61M 1/362223* (2022.05); *A61M 1/36225* (2022.05); *A61M 1/36226* (2022.05); *A61M 2205/121* (2013.01)

(58) **Field of Classification Search**
CPC A61M 1/36225; A61M 1/36226; A61M 1/367; A61M 2205/121; A61M 60/113; A61M 60/847; B01L 9/527
See application file for complete search history.

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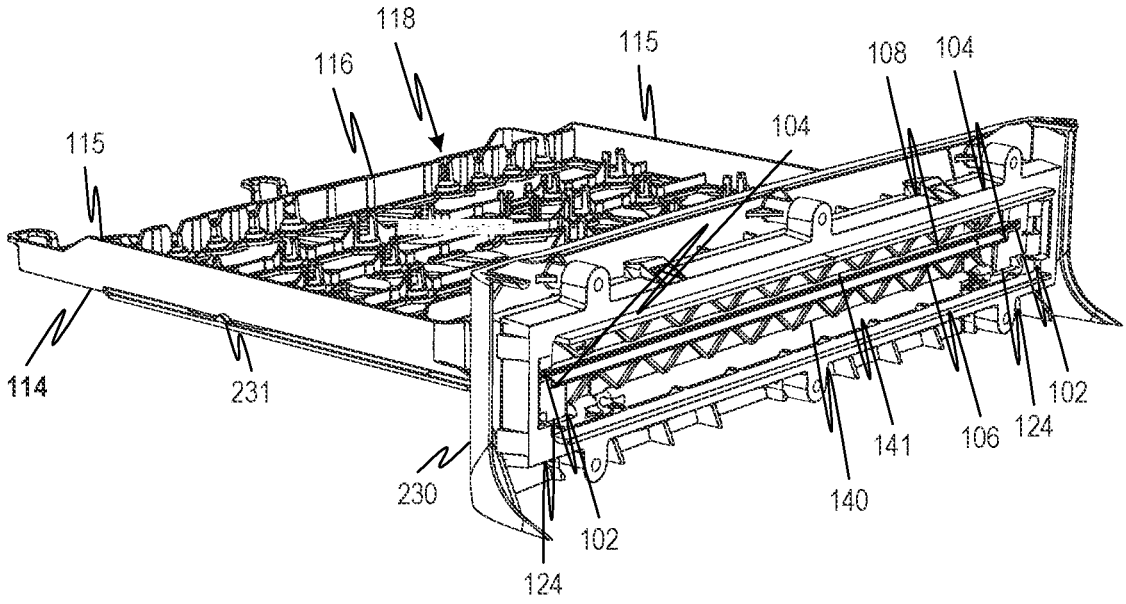
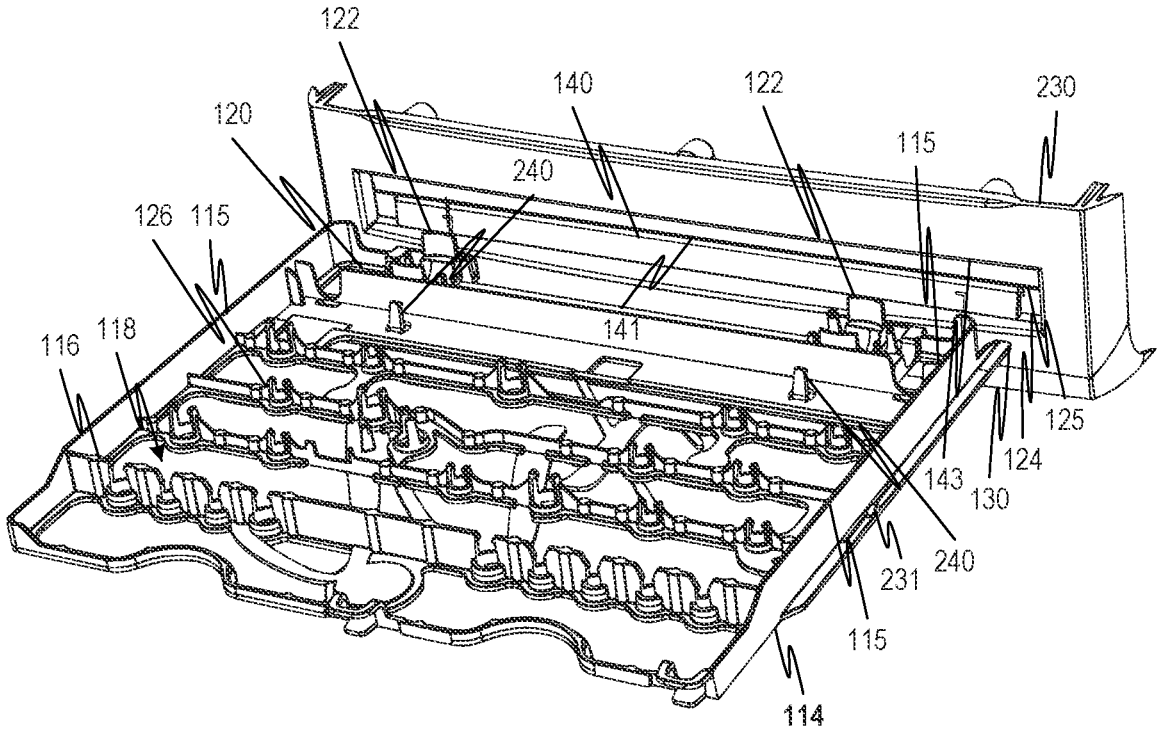

118
116
115
108
104
115
104
114
231
230
102
124
140
141
106
124
102

Fig. 1A


122
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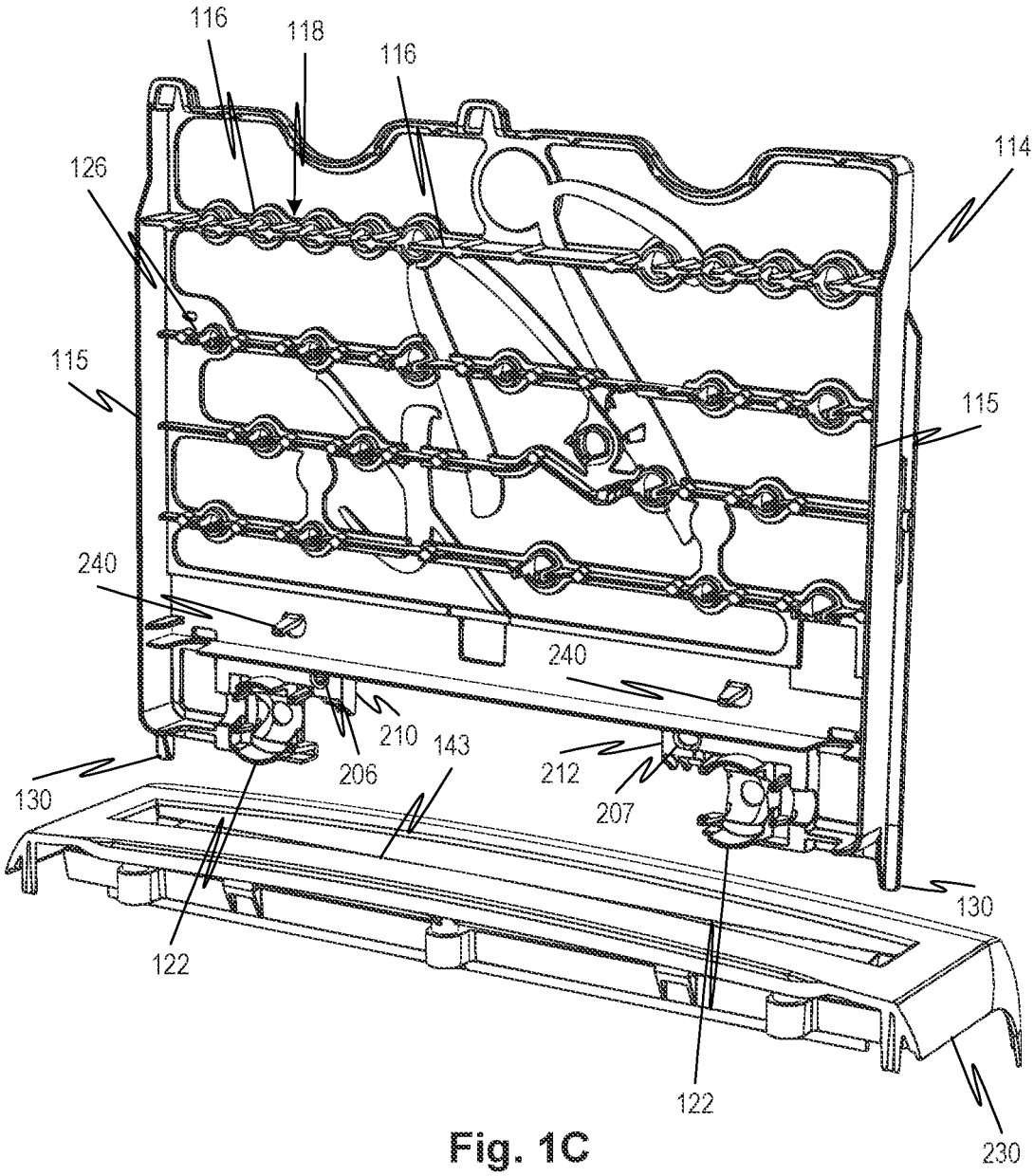
231
115
114

Fig. 1B


116
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126
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115
115
240
240
210
143
206
212
207
130
130
122
122
230

Fig. 1C

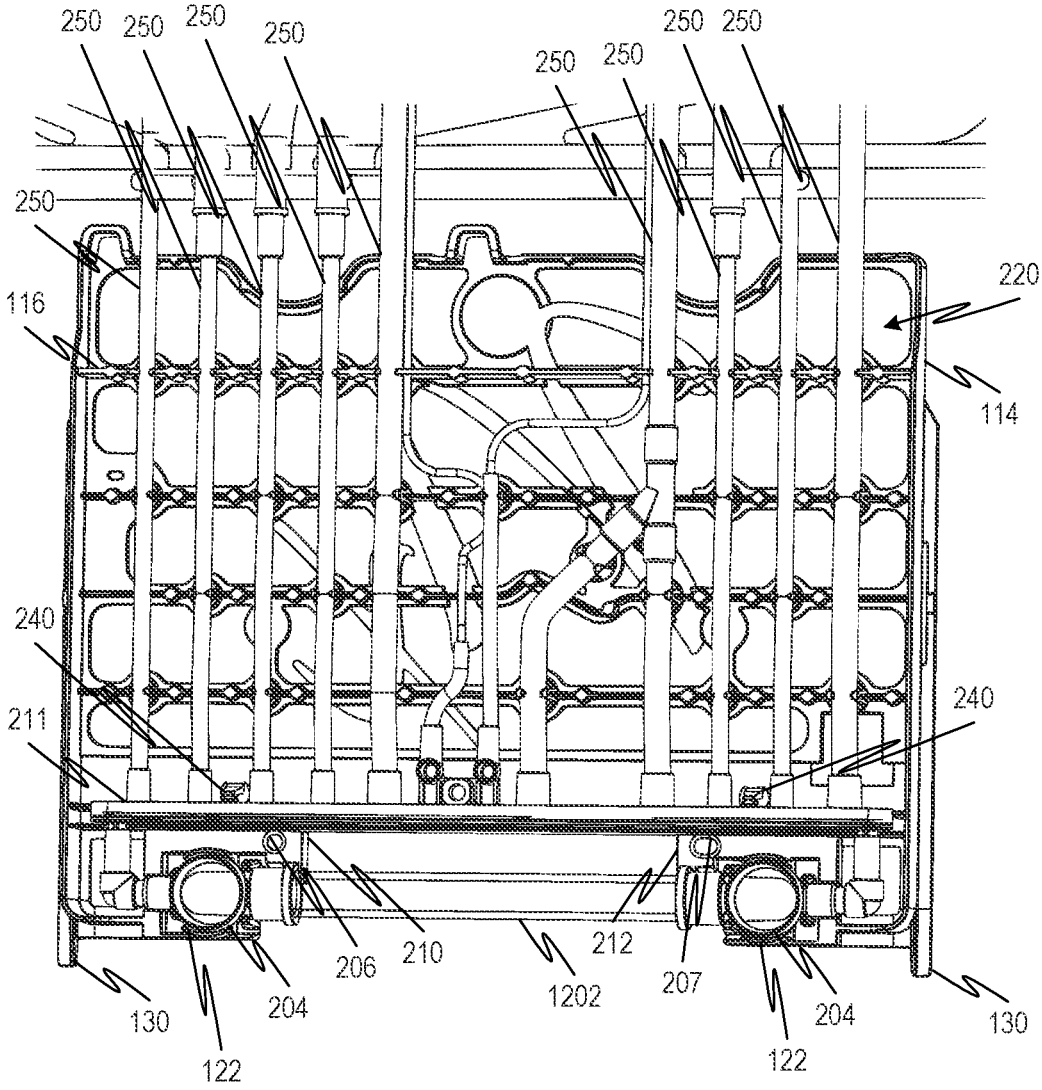
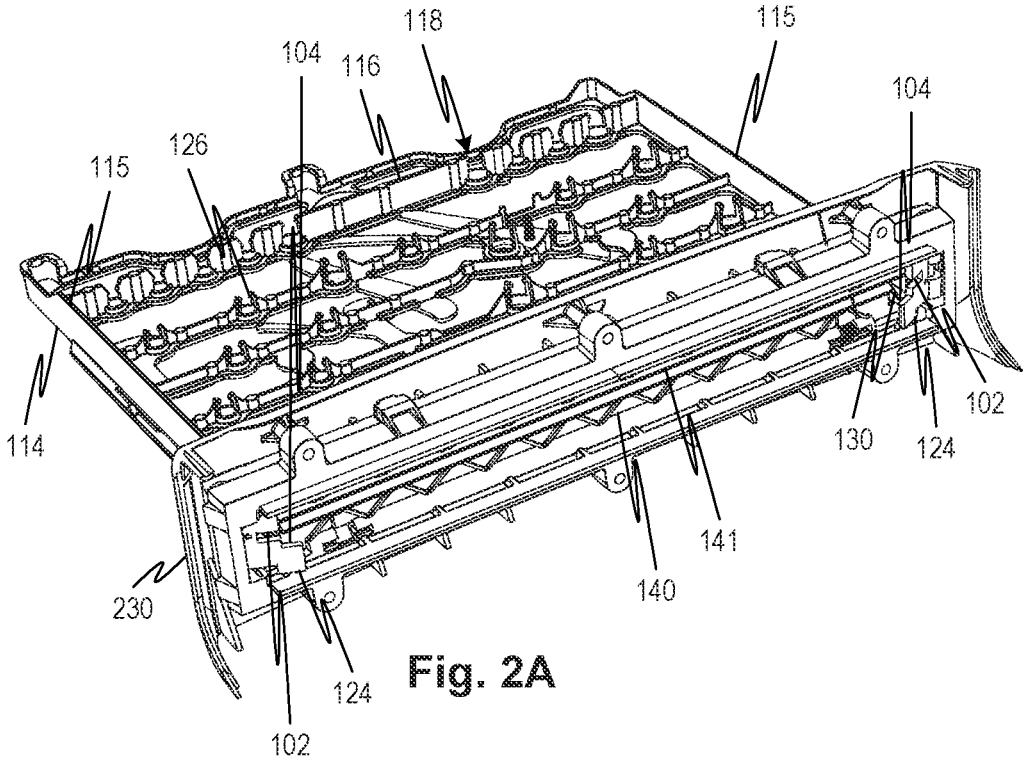

250
250
250
250
250
250
250
250
250
220
116
114
240
211
240
206
210
212
207
1202
130
204
122
204
122
130

Fig. 1D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126
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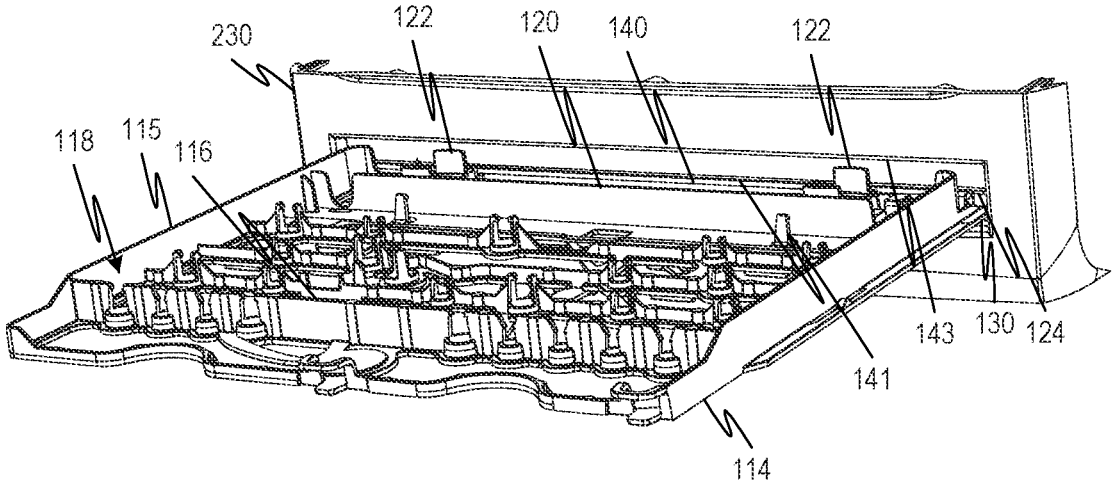
130
124
102
141
140
230
124
102

Fig. 2A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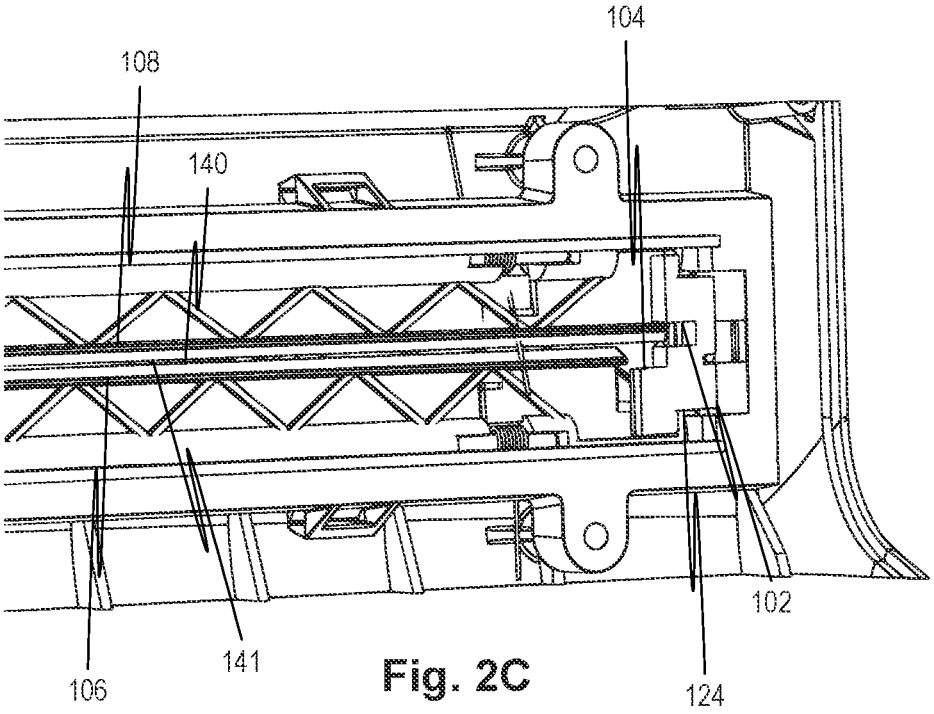
122
120
140
122
118
115
116
143
130
124
141
114

Fig. 2B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102
106
141
124

Fig. 2C

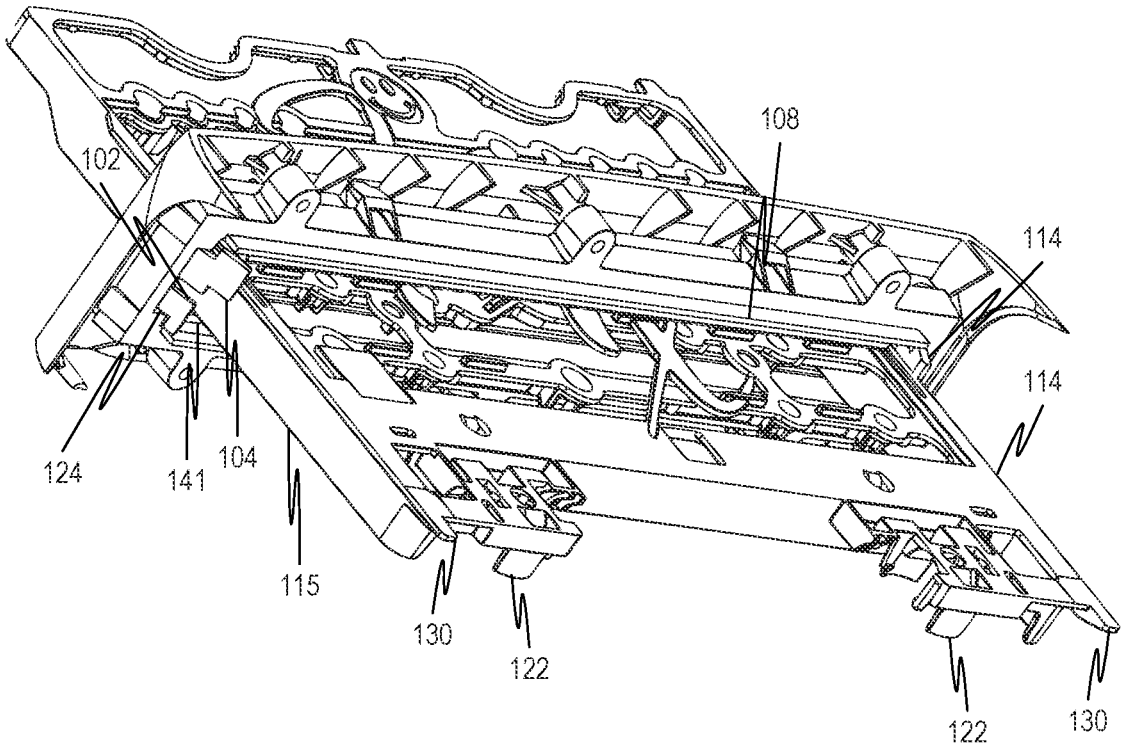
108
102
114
114
124
141
104
115
130
122
122
130

Fig. 3

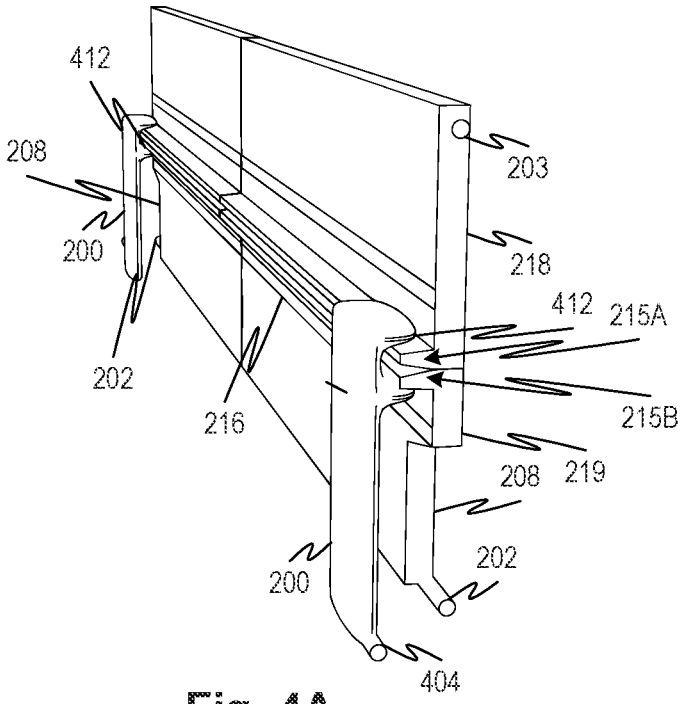
412
208
200
202
216
203
218
412
215A
215B
208
219
202
200
404

Fig. 4A

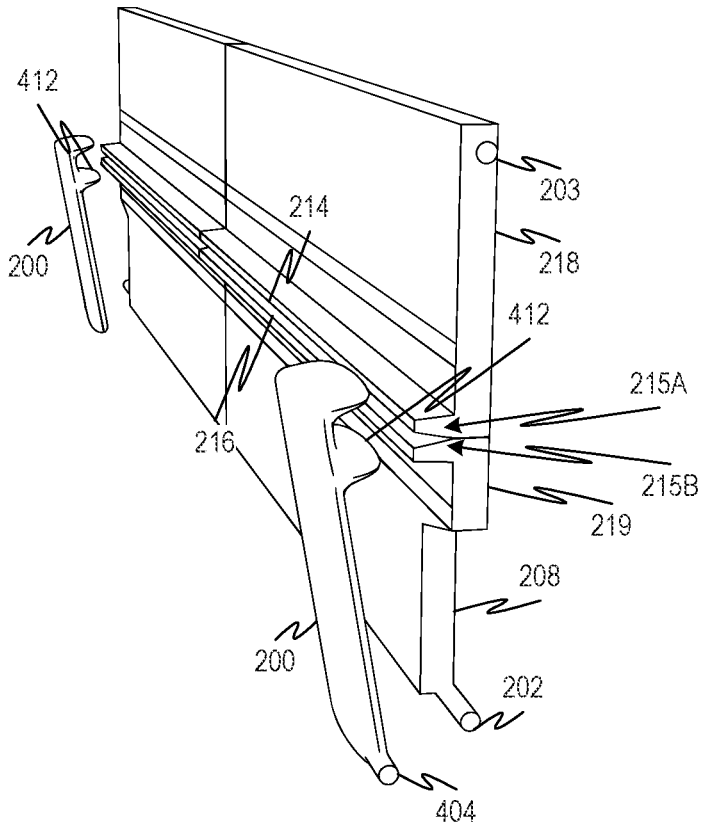
412
200
214
216
203
218
412
215A
215B
219
208
200
202
404

Fig. 4B

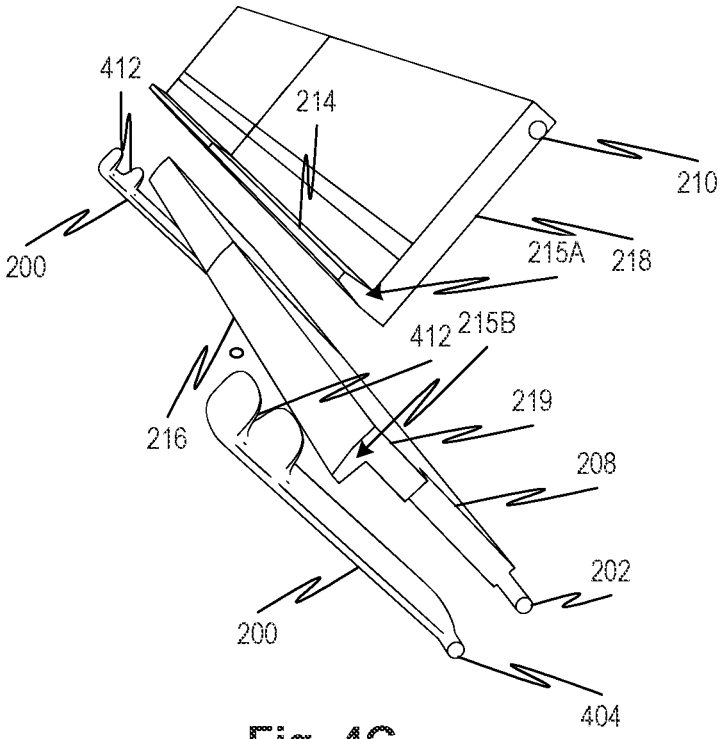
412
214
210
200
215A
218
412
215B
219
216
208
202
200
404

Fig. 4C

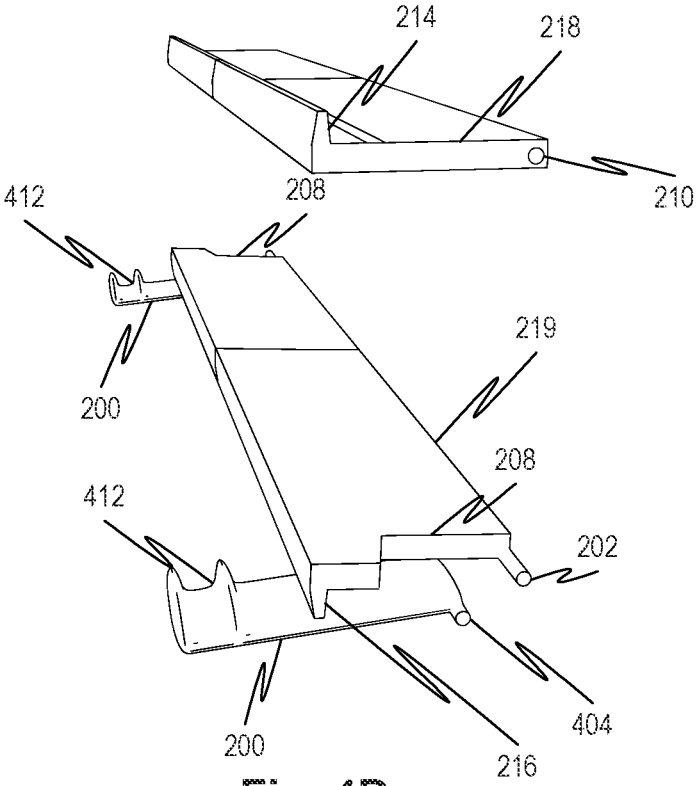
214
218
208
210
412
219
200
208
412
202
404
200
216

Fig. 4D

MEDICAL DEVICE LOADING SYSTEMS, DEVICES, AND METHODS

CROSS-REFERENCE TO RELATED APPLICATIONS

This Application is a U.S. national stage filing under 35 U.S.C. § 371 of International Application No. PCT/US2020/027431, filed Apr. 9, 2020, which claims priority to and the benefit of U.S. Provisional Patent Application No. 62/831,352 filed Apr. 9, 2019 and U.S. Provisional Patent Application No. 62/940,358 filed Nov. 26, 2019, all of which are hereby incorporated by reference in their entireties.

BACKGROUND

Fluid circuits adapted to cartridge-borne fluid circuits for loading into medical devices are known. See for example, U.S. Pat. No. 6,852,090. There is an on-going need for improvements in the convenience and simplicity of devices for connecting cartridge-borne fluid circuits in medical devices.

SUMMARY

A cartridge loading mechanism unlocks doors of a slot opening of a medical treatment device. Key pins on a cartridge chassis push on latches to force them out of engagement with ridges on the doors which protect the slot opening.

Objects and advantages of embodiments of the disclosed subject matter will become apparent from the following description when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments will hereinafter be described in detail below with reference to the accompanying drawings, wherein like reference numerals represent like elements. The accompanying drawings have not necessarily been drawn to scale. Where applicable, some features may not be illustrated to assist in the description of underlying features.

FIGS. **1**A, **1**B, and **1**C show a cartridge chassis configured to support a fluid circuit in position to be loaded into a slot opening of a medical treatment device with only a portion of the housing of the medical treatment device being visible in the drawing according to embodiments of the disclosed subject matter.

FIG. **1**D shows a cartridge chassis of the embodiments of FIGS. **1**A, **1**B, and **1**C, with fluid circuit elements attached thereto according to embodiments of the disclosed subject matter.

FIGS. **2**A, **2**B, and **2**C show the cartridge chassis of FIGS. **1**A, **1**B, and **1**C partially loaded into a slot opening of a medical treatment device with only a portion of the housing of the medical treatment device being visible in drawing according to embodiments of the disclosed subject matter.

FIG. **3** shows the cartridge chassis of FIGS. **1**A, **1**B, and **1**C substantially loaded into the medical treatment device according to embodiments of the disclosed subject matter.

FIGS. **4**A, **4**B, **4**C and **4**D show a latch and door mechanism in various configurations before and after insertion of a chassis with respective keys according to embodiments of the disclosed subject matter.

DETAILED DESCRIPTION

Referring to FIGS. **1**A and **1**B, a cartridge chassis **114** has a frame with side walls **115** and forward and rear fences **120** and **116**, respectively. The cartridge chassis **114** has a generally rectilinear shape with generally uniform depth, the depth direction being indicated at **157** in FIG. **1**A. The forward fence **120** sits just behind a pair of pressure pod supports **122**. The pressure pod supports **122** are located just behind the tips of a pair of key pins **130**, one on either side of the cartridge chassis **114**. The key pins push on latches **124** partly visible through openings **125** in doors **140** and **141** that selectively close and open a slot opening **143**. FIGS. **1**A and **1**B show the cartridge chassis **114** immediately prior to being inserted in the slot opening **143**. As the cartridge chassis **114** is moved toward the slot opening **143** in housing portion **230**, the key pins **130** pass into openings **125** to push on latches **124** causing them to swing to the side on hinges whose axes are perpendicular to the longitudinal axis of the slot opening **143** in housing portion **230**. The latches **124** are visible from the opposite side of the housing portion **230** as shown in FIGS. **1**A and **2**A. Detente pins **231** are supported resiliently on the cartridge chassis **114** so that they can engage a recess in a receiving slot (not shown).

The doors may have springs to bias them toward a closed position. The chassis keeps the doors open when the cartridge chassis **114** is fully inserted. As the cartridge chassis **114** is withdrawn the doors prevent the latches from closing by remaining in interfering engagement therewith such that the latches **124** cannot close before the doors close. Thus the latches **124** are the first to open and the last to close when the cartridge chassis **114** is pushed in and when the cartridge chassis **114** is withdrawn.

Note that FIGS. **2**A, **2**B, and **2**C show the cartridge chassis **114** partly pushed into the slot opening **143** such that the key pins **130** have engaged the latches **124** and partially pushed them to the side thereby releasing the doors **140** and **141** such that the cartridge chassis **114** can push the doors **140** and **141** open and hold them open while inside the slot opening **143**. Side walls **115** span the entire depth of the chassis such that the doors **140** and **141** are held completely open while the cartridge chassis **114** is inserted in the slot opening **143**.

The latches **124** have edges **102** and **104** that interferingly engage ridges **106** and **108** to hold the doors **140** and **141** closed. When the latches **124** are pushed to the side these edges **102** and **104** are moved to the said allowing the doors **140** and **141** to open as the cartridge chassis **114** is urged into the slot opening **143** by a user.

Note that FIGS. **1**A-**1**C, **2**A-**2**C and **3** show the cartridge chassis **114** with no fluid circuit **220** whilst FIG. **1**D shows the cartridge chassis **114** with a fluid circuit **220**. The fluid circuit **220** is attached to the cartridge chassis **114** when the device is fully manufactured as a system and while in use but in order to illustrate the function of the door latching system, the fluid circuit is omitted in FIGS. **1**A through **1**C. Tubes of the fluid circuit **220** are held by an array of clips **126** and slots **118** in the rear fence **116**. As visible in FIG. **1**D, pressure pods **204** are held by pressure pod supports **122**. The pressure pod supports **122** are supported on tabs **210** and **212** that have locator holes **206** and **207**, respectively. A pumping tube segment **1202** runs between the pressure pods **204** spanning a separation between the tabs **210** and **212**. The pumping tube is supported by the pressure pods which are in turn supported by tabs **210** and **212**. The locator hole **206** is round and the locator hole **207** is oval shaped. The oval shape provides some compliance to accommodate manufacturing variation with respect to the positions of alignment pins that are inserted in the locator holes **206** and **207** when the cartridge chassis **114** is inserted completely

through the slot opening **143**. The fluid circuit **220** has a manifold portion **211** that is held in the cartridge chassis **114** by clips **240**.

Referring to FIG. **1**D, the fluid circuit **220** has an array of tubes **250** extending from the manifold portion **211** that run to and extend beyond the rear fence **116** and extend straight rearwardly. When the cartridge chassis **114** is fully inserted, the tubes extend away from the slot opening **143**. The rear fence **116** aligns with the mouth of the slot opening **143** when the cartridge chassis **114** is fully inserted such that the slot opening **143** is substantially covered by the rear fence **116**. It can be seen in FIG. **1**D that the key pins **130** extend beyond the pressure pod supports **122** and as such are thereby able to make contact with the latches **124** before the cartridge chassis **114** makes contact with the doors **140** and **141** as the cartridge chassis **114** is progressively pushed into the slot opening **143**. The length of the key pins **130** is such that the latches **124** are swung far enough aside that the doors **140** and **141** are released to open before the cartridge chassis **114** makes contact with the doors. Thereafter, the doors are held open by the side walls **115** and the bottom of the cartridge chassis **114**.

In FIG. **3**, the cartridge chassis **114** has been inserted substantially, but not fully, through the slot opening **143** so that the latches **124** are pivoted to the side. The doors **140** and **141** are fully held apart by the side walls **115** and the cartridge chassis **114** bottom (the cartridge chassis **114** bottom facing upward from the viewpoint of FIG. **3**).

Referring now to FIG. **4**A, a door **218** is held closed with a door **219** by jaws **412** of two latches **200**, one at either end of the doors **218** and **219**. The doors **218** and **219** are held closed because edges **214** and **216** on ridges **215**A and **215**B on the doors **218** and **219** remain in interfering engagement with the jaws **412**. The door **219** has a cutout **208** near a hinge **202** (shown as a pivot pin) of the door **219** at each end thereof. Door **218**, on the other hand, does not need a cutout near its hinge **203**, in this embodiment. The latches **200** pivot on respective pins **404**. When keys of a chassis (not shown in the present drawing but similar to those shown in the previous embodiments) are inserted through the cutouts **208**, the latches **200** are forced away from the ridges **215**A and **215**B releasing the doors **218** and **219** as shown in FIG. **4**B. As shown in FIG. **4**C, as the chassis (not shown) is pushed further, the door **219** pushes the latches **200** out of the way as the chassis is forced against the door **219**. The door **218** is similarly to the side. FIG. **4**D shows the positions of the doors **218** and **219** after being forced open by the chassis. The removal of the chassis results in the reverse sequence. It will be observed that the latches **200** are the first to open and the last to close as in the embodiments described above.

It will be appreciated that the embodiment in FIGS. **4**A and **4**B can be modified to omit one of the latches **200**, while retaining its functionality. Furthermore, a third latch **200** could be added, for example near the middle of the doors, with a corresponding cutout in the appropriate door, to create a more unique key pattern that needs to be matched before the doors open and permit a cartridge to be inserted. This is particularly advantageous to prevent the insertion of incorrect cartridges into the system.

According to first embodiments, the disclosed subject matter includes a cartridge insertion system. In the system, a chassis supports a fluid circuit. The chassis has a forward end with key pins projecting from the forward edge and a rear end. A medical treatment device has a slot opening closed by doors, the doors having key openings spaced apart a same distance as the key pins such that when the chassis is pushed toward the slot opening, the key pins enter the key openings before the forward end meets the doors. Latches on the medical treatment device immediately behind the key openings each configured to pivot on a latch axis. The doors pivoting on door axes parallel to the major dimension. The latches and doors are configured to interfere such that when the latches are closed, prior to contact with the key pins, the doors are prevented from opening and such that when the key pins push against the latches, the latches swing to one side, releasing the doors.

The first embodiments can be modified to form additional first embodiment in which the key openings are located to one side of a major dimension of the slot opening. The first embodiments can be modified to form additional first embodiment in which the latch axis is perpendicular to the major dimension. The first embodiments can be modified to form additional first embodiment in which the latches have opposing facing edges that engage with ridges on the doors when the doors are closed and the latches are in a home position prior to being pushed by the key pins. The first embodiments can be modified to form additional first embodiment in which the cartridge holds the doors open and the doors are spring loaded to close such that when the latches return to a home position the doors are locked and prevent objects from being inserted. The first embodiments can be modified to form additional first embodiment in which the cartridge holds the doors open and the doors are spring loaded to close such that when the latches return to a home position the doors are locked and prevent objects from being inserted. The first embodiments can be modified to form additional first embodiment in which the objects are fingers thereby preventing a hazard. The first embodiments can be modified to form additional first embodiment in which the fluid circuit has tubes that project away from the rear end extending beyond the rear end to connect to connectors remote from the chassis. The first embodiments can be modified to form additional first embodiment in which the tubes are generally parallel.

The first embodiments can be modified to form additional first embodiment in which the chassis projects partly from the slot, opening when fully inserted in the medical treatment device. The first embodiments can be modified to form additional first embodiment in which the fluid circuit includes a pumping tube segment connected to the chassis. The first embodiments can be modified to form additional first embodiment in which the pumping tube segment is positioned parallel to the major dimension when the chassis is oriented for insertion in the slot opening. The first embodiments can be modified to form additional first embodiment in which the pumping tube segment lies between a major portion of the chassis and a line connecting tips of the key pins. The first embodiments can be modified to form additional first embodiment in which the pumping tube segment is attached to pressure pods at either end of the pumping tube segment. The first embodiments can be modified to form additional first embodiment in which the pumping tube segment is supported by the pressure pods.

The first embodiments can be modified to form additional first embodiment in which the pressure pods are supported by tabs extending from the chassis, the tabs having locator holes. The first embodiments can be modified to form additional first embodiment in which the chassis has a rear fence with slots for the tubes. The first embodiments can be modified to form additional first embodiment in which the rear fence is aligned with the slot opening when the chassis is fully inserted in the medical treatment device. The first embodiments can be modified to form additional first embodiment in which the chassis has detente pins along

opposite sides thereof between the forward end and the back end, the detente pins being supported resiliently so as to flex when pushed. The first embodiments can be modified to form additional first embodiment in which the chassis has a generally uniform depth, the depth being perpendicular to two major dimensions thereof. The first embodiments can be modified to form additional first embodiment in which the doors prevent the latches from closing by remaining in interfering engagement therewith such that the latches cannot close before the doors close. The first embodiments can be modified to form additional first embodiment in which, when the chassis is inserted in the slot opening, the latches are the first to open and when the chassis withdrawn from the slot opening, latches are the last to close.

According to second embodiments, the disclosed subject matter includes a cartridge in which a chassis supports a fluid circuit, the chassis having a forward end with key pins projecting from the forward edge and a rear end. The fluid circuit has tubes that project away from the rear end extending beyond the rear end to connect to fluid circuit portions remote from the chassis. The chassis has a rear fence inboard of a the rear end. The fluid circuit includes a pumping tube segment connected to the chassis. The pumping tube segment lies between a major portion of the chassis and a line connecting tips of the key pins.

The second embodiments can be modified to form additional second embodiments including the cartridge described above, wherein the pumping tube segment is attached to pressure pods at either end of the pumping tube segment. The second embodiments can be modified to form additional second embodiment in which the pressure pods are supported by tabs extending from the chassis, the tabs having locator holes. The second embodiments can be modified to form additional second embodiment in which the tubes are generally parallel.

The second embodiments can be modified to form additional second embodiment in which the pumping tube segment is attached to pressure pods at either end of the pumping tube segment. The second embodiments can be modified to form additional second embodiment in which the pumping tube segment is supported by the pressure pods.

The second embodiments can be modified to form additional second embodiment in which the chassis has a rear fence with slots for the tubes. The second embodiments can be modified to form additional second embodiment in which the rear fence is aligned with the slot opening when the chassis is fully inserted in the medical treatment device. The second embodiments can be modified to form additional second embodiment in which the chassis has detente pins along opposite sides thereof between the forward end and the back end, the detente pins being supported resiliently so as to flex when pushed.

It is, thus, apparent that there is provided, in accordance with the present disclosure, medical device loading systems, devices, and methods. Many alternatives, modifications, and variations are enabled by the present disclosure. Features of the disclosed embodiments can be combined, rearranged, omitted, etc., within the scope of the invention to produce additional embodiments. Furthermore, certain features may sometimes be used to advantage without a corresponding use of other features. Accordingly, Applicants intend to embrace all such alternatives, modifications, equivalents, and variations that are within the spirit and scope of the present invention.

What is claimed is:

1. A cartridge insertion system, comprising:

a chassis supporting a fluid circuit, the chassis having a forward end with key pins projecting from said forward end and a rear end;

a medical treatment device having a slot opening closed by doors having a major dimension, the doors having key openings spaced apart a same distance as said key pins such that when said chassis is pushed toward said slot opening, said key pins enter said key openings before said forward end meets said doors;

latches on said medical treatment device immediately behind said key openings, each of the latches configured to pivot on a latch axis;

the doors pivoting on door axes parallel to the major dimension; and

the latches and the doors being configured to interfere such that when the latches are closed in a home position, prior to contact with said key pins, the doors are prevented from opening and such that when said key pins push against said latches, the latches move to one side, releasing the doors.

2. The system of claim **1**, wherein said key openings are located to one side of the major dimension of said slot opening.

3. The system of claim **1**, wherein said latch axis is perpendicular to said major dimension.

4. The system of claim **1**, wherein said latch axis is parallel to said major dimension.

5. The system of claim **1**, wherein said latches have opposing facing edges that engage with ridges on said doors when the doors are closed and the latches are in the home position prior to being pushed by the key pins.

6. The system of claim **5**, wherein the cartridge holds the doors open and the doors are spring loaded to close such that when the latches return to the home position the doors are locked and prevent objects from being inserted.

7. The system of claim **1**, wherein the cartridge holds the doors open and the doors are spring loaded to close such that when the latches return to the home position the doors are locked and prevent objects from being inserted.

8. The system of claim **1**, wherein the fluid circuit has tubes that project away from said rear end extending beyond said rear end to connect to connectors remote from said chassis, and

said tubes are generally parallel.

9. The system of claim **1**, wherein said fluid circuit includes a pumping tube segment connected to the chassis.

10. The system of claim **9**, wherein the pumping tube segment is positioned parallel to said major dimension when the chassis is oriented for insertion in said slot opening.

11. The system of claim **9**, wherein said pumping tube segment lies between a major portion of the chassis and a line connecting tips of said key pins.

12. The system of claim **9**, wherein said pumping tube segment is attached to pressure pods at either end of the pumping tube segment.

13. The system of claim **1**, wherein said chassis has a rear fence with slots for tubes, and

said rear fence is aligned with the slot opening when said chassis is fully inserted in said medical treatment device.

14. The system of claim **1**, wherein the chassis has a generally uniform depth, the depth being perpendicular to two major dimensions thereof.

15. The system of claim **1**, wherein the doors prevent the latches from closing by remaining in interfering engagement therewith such that the latches cannot close before the doors close.

16. The system of claim 1, wherein, when the chassis is inserted in the slot opening, the latches are first to open and when the chassis withdrawn from the slot opening, the latches are last to close.

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